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Abstract

This paper examines the impact of prospective demographic trends in the population structure of Puerto Rico. Puerto Rico has experienced the first population decline in recorded history, which brings forth the question of the future of the population of the island and what are the policy implications of the transformations of the population. A Cohort-Component Projections was used, incorporating rates of changes for fertility and mortality based in historical patterns. The net migration rates were calculated using the Residual Method or Vital Statistics Method, and three different scenarios were explored: (1) Full Migration, (2) Half Migration and (3) Zero Migration. Our results point to a continuing decrease in the population of Puerto Rico, even when considering a Zero Migration scenario. Below replacement fertility will still be a key element of this decline, and the prospective trends do not point the declining levels of fertility stopping in the coming decades. Mortality has a consistent and stable structure, even when considering the rates of change for the whole population. Because of this we kept the Survival Rates from the original Life Tables for 2010. The methods employed in our analysis point to a systemic aging of the population of Puerto Rico, the population pyramid gearing towards a state of contraction and to an "inverted pyramid" by 2030. The median age will continue increasing and so will the percentage of persons in the aged age groups. Additionally, we see an increment in dependent population highly fueled by the contraction of the working-age group and the increment in the aged population of Puerto Rico. From a policy perspective, the government of Puerto Rico will have to deal with this population decline and aging in a timely manner should they want to avoid the catastrophic consequences of not addressing the situation in a timely manner.

Keywords: population decline, Puerto Rico, prospective trend, cohort components, projections

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Introduction

On 2010, Puerto Rico woke up to an unspoken reality; the population of the island was decreasing (Figueroa-Rodriguez and colleagues, 2012). The 2010 Census indicated that the population of the island summed 3,725,789 persons (US Census, 2010). For the 2000 period the population of the island added up to 3,808,610 persons. A comparison of both census counts evidences the first population decline of Puerto Rico, a decline of 2.17%. The long held expectation that the island would reach 4 million inhabitants dissolved while the government received with surprise the alarming news.

Despite having an unstable trajectory with regards to population growth, a population decline had not been projected by academics, researchers, planning centers or by government authorities. The purpose of this paper is to project the population of Puerto Rico while incorporating trends in the population dynamics as well as to discuss the public policy implications of the population prospects for Puerto Rico. This paper seeks to illustrate the need for better estimates and projections, with the objective of transforming these in tools for policy decision making and guides for economic and social planning.

POPULATION TRENDS 1910-2010

The population trends for Puerto Rico in decades before 2010 had tended to population growth. Despite having a population growth rate that had oscillated between 6% and 20%, this rate never approached the zero growth not the negative growth area (Vázquez-Calzada, 1988). Figure 1 presents the pattern of census counts for the 1910-2010.

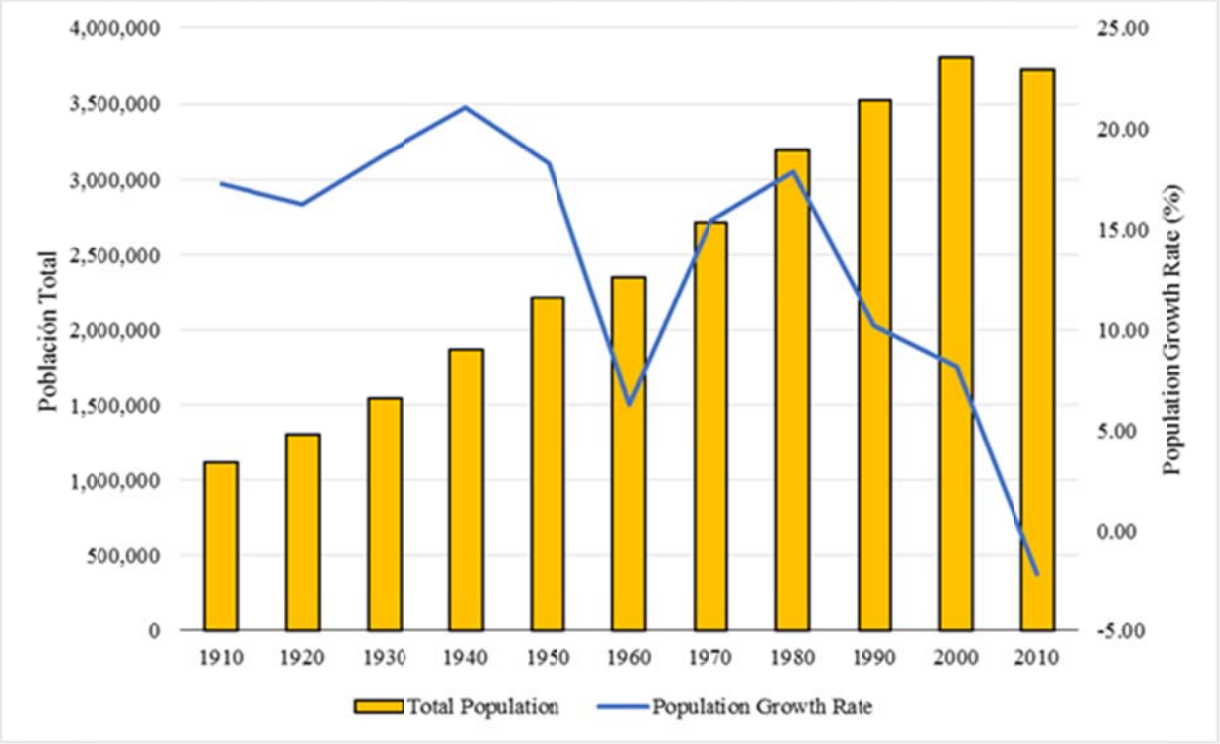

Figure 1 Total Population and Population Growth Rates for Puerto Rico 1910-2010

As it can be appreciated, from 1910 until 1950 the growth rate remained relatively stable and remained over 15%. For the 1950-1960 the growth rate experienced the first deceleration of growth (Myers, 1967). This decline did not happen randomly. During the previous decade the government of Puerto Rico evolved from a colonial system of government to a fully democratic structure resembling the structure of the US Government (Dietz, 1987).

The government structure known as "Freely Associated State" or Commonwealth incentivized the migration of poor population to the United States as means to escape their economic conditions with promises of better jobs, and social welfare in the mainland. The availability of agriculture, manufacture and industrial sector were the primary drivers of this mass migration to the United States during that decade (Maldonado, 1979). This mass migration of Puerto Ricans was possible because the United States Congress extended citizenship to all persons born in Puerto Rico under the Jones Act of 1917 (Rivera-Batiz and Santiago, 1998; Senior, 1958). At the beginning of the 1960s, Puerto Rican communities or "colonias" existed in states like New York, New Jersey, Illinois and California (Hernández-Alvarez, 1968).

On the subsequent decades the patterns of population growth returned to the over 15% level. After the 1980s, the population growth of Puerto Rico experienced a deceleration which

has continued until our days. Despite the intensification of the deceleration of growth no one expected a population decline to happen in 2010 (Figueroa-Rodríguez, 2013). Using arithmetic extrapolative techniques the population growth rate for the 2000-2010 should have been between 4.7% and 7.5%. Even when allowing a 95% error in this measurement, the rate did not approach the zero growth level. This accentuates the need to closely watch the population trends of our places of study to develop better population estimates and projections.

Figure 2 presents multiple population estimates by the US Census Bureau and the Puerto Rico Planning Board and the population counts for 2000 and 2010. As it can be appreciated, the population of Puerto Rico was estimated for 2009 and 2010 to be close and over the 4 million ceiling. These estimates were used to assign government resources for projects including: 1) building and modernization of schools, 2) borrowing money from bondholders, 3) development and approval of permits for housing projects. These examples relied heavily in a growing population to be sustained. At the end of the decade the government noticed a yearly decrease of 16,500 students attending public school (Cámara de Representantes, 2012), the government projections for tax revenues were not met even with the amendment of tax measures and the approval of additional taxes and 30,000 houses remained in the market without any potential buyer (Cámara de Representantes, 2012). This scenario tied to the preliminary results of the US Census was a call for a revision of previous population estimates and of the assumptions behind them.

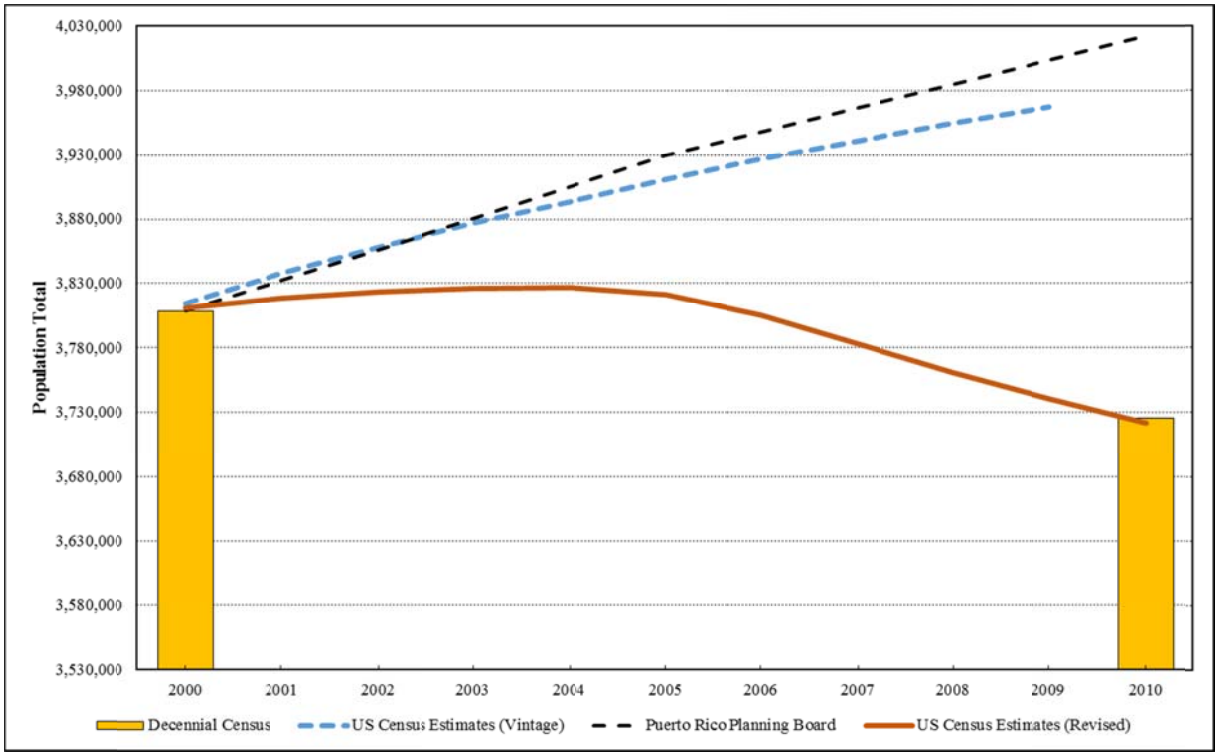

Figure 2 Population Counts for 2000 and 2010, and Population Estimates 2000-2010

A meticulous revision of the assumptions using the Puerto Rico Community Survey (PRCS), allowed identifying two crucial elements in this population decline: (1) the decline to fertility to 1.6 children by women, indicator that had remained below replacement in 2000 where it was calculated to be 2.04 children by women (Departamento de Salud, 2012) and (2) the mass migration of Puerto Ricans from the island to mainland United States. The possible drivers of this migration were better job opportunities, and improved social and economic conditions (Figueroa-Rodriguez and colleagues, 2012; Figueroa-Rodriguez, 2013). The net migration for this decade was of -294,442 individuals, which translates in a -7.90% net migration rate. The US Census revised the population estimates in light of the new evidence of a dramatic change in the population dynamics of Puerto Rico (Figure 2, Orange Line). The new estimate pointed to 2004 being the point of inflexion for the population of Puerto Rico, meaning 2005 was the first year when the population decline started, a decline that has not stopped in 2015. In 2013, the population of Puerto Rico was calculated to be 3.6 million persons; a number lower than the population count for the 2010 Decennial Census.

Studying the population trends for Puerto Rico, even in 2010 a population decline was not to be expected if we only considered birth rates and mortality rates. As it can be appreciated in Figure 3, even in 2010 the population was expected to grow. This accentuates the role that migration had in the population dynamics of the island for that period. In the current moment the prominent Puerto Rican Demographer, Raúl Figueroa has indicated that this reality is about to change. In the coming years, the mortality rate will be higher than the birth rates, which will further accelerate the population decline of the island. This is captured by incorporating the prospective trends in the fertility component in the population projections.

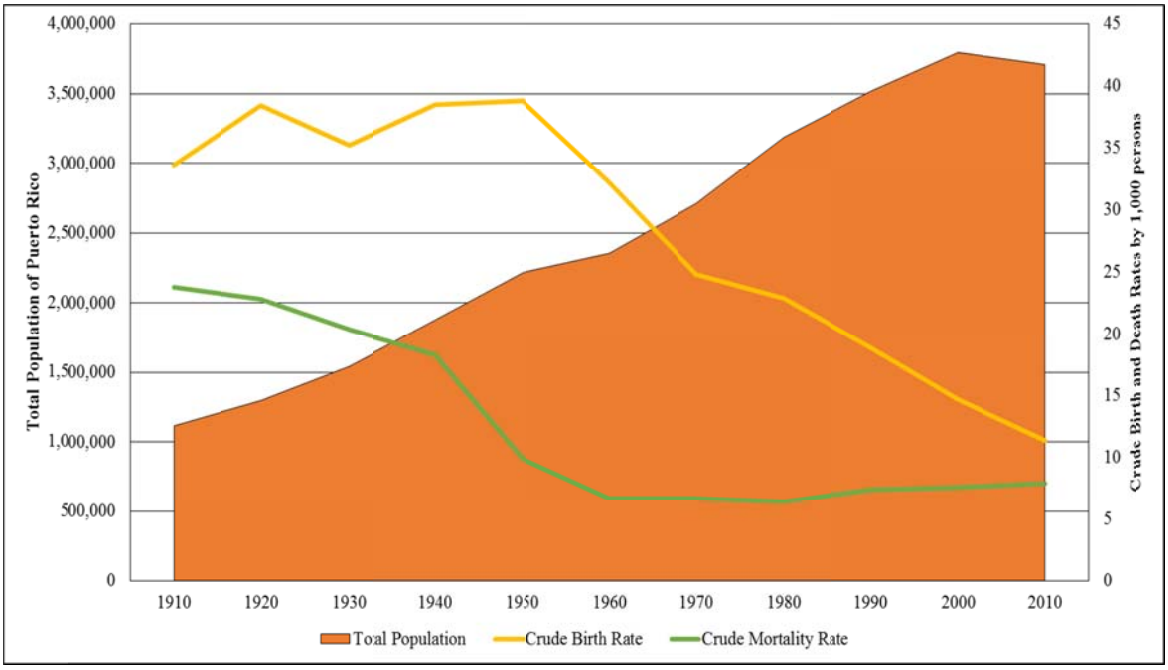

Figure 3 Population Trends for the Population of Puerto Rico 1910-2010

The objective of this paper is to project the population of Puerto Rico, while taking in consideration the trends observed in the three demographic processes. Additionally, we will speak about the projected transformations of the Puerto Rican population in the island in terms of age structure and discuss the implications of these transformations for public policy purposes.

DATA AND METHODS

Data

Data for this study come from multiple sources. Age and sex structures for 2000 and 2010 were obtained from the Decennial Census (US Census, 2000; US Census, 2010). For purposes of the projections the 2000 structure is used as a base year, and 2010 is used as a referent to compare the accuracy of the projections. We will discuss specific sources of information for the demographic processes in each specific section.

Cohort-Component Projections

The Cohort Component Method II depends on the use of three characteristics of population that determine population change, which are also known as the three demographic processes these are: Births, Deaths and Net Migration. For any period the population can be determined using the following equation:

$$Pt = Po + B – D + (NM)$$

Where Pt is the population at projection period, Po is the population at base period, B are the births between Pt and Po, D are the between Pt and Po and NM is the net migration between Pt and Po. In the following sections we will explain how each component was incorporated in our projections and how we allowed some variation in the fertility and migration baseline indicators.

Fertility: Prospective Trends

Age Specific Fertility Rates (ASFR) were computed using births by age of the mother for 2000 and 2010. The 2000 ASFRs were used for the projection of population from 2000 until 2010. The numerators for the rates were the births for 2000 or 2010 and the denominators were the age-specific population counts for each census years. Birth data for the 2000-2010 period were obtained from the Puerto Rico Birth Files published by the National Center for Health Statistics (NCHS). Births were aggregated by five year age groups.

We have incorporated the average rate of change for the fertility rates. According to Rowland (2003) some researchers incorporate the rate of change in the different demographic processes when calculating population projections. According to Dávila (2013) fertility has been decreasing for each decade since the 1970s. According our calculations the fertility rates for Puerto Rico will remain below replacement and continue decreasing in the coming years. The expected fertility rates are presented in Figure 4; additionally we present the projected Total Fertility Rates (TFR) in Figure 5.

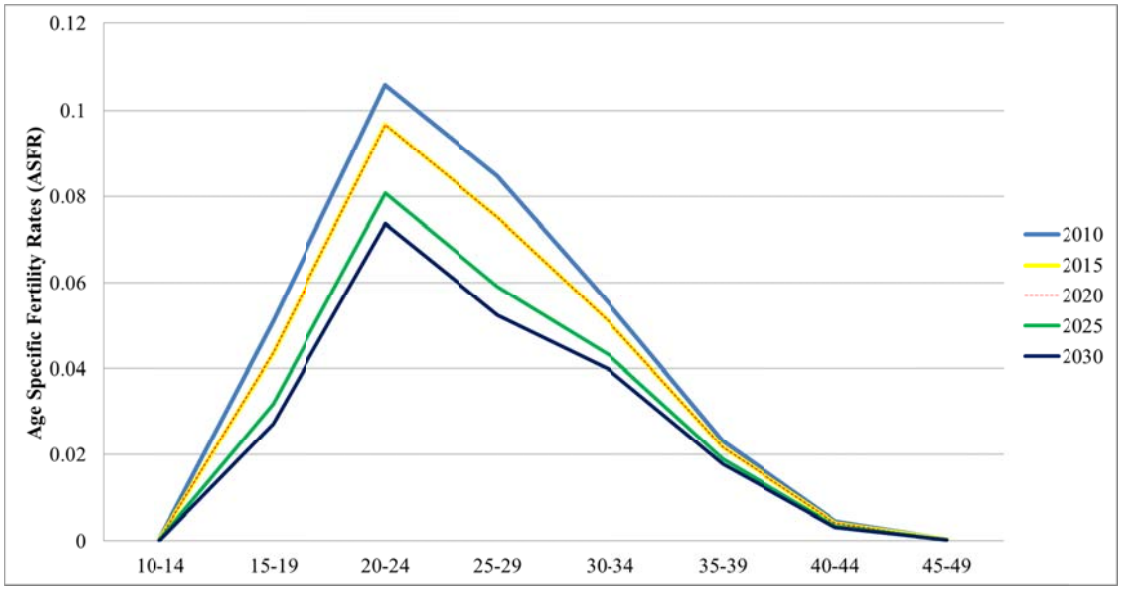

Figure 4 Projected Age-Specific Fertility Rates (ASFR) for Puerto Rico, 2010-2030.

To arrive to our projected ASFR, we used the mean change rate from 2000 to 2010, and used of the half of the rate to project the ASFR for the coming five year periods.

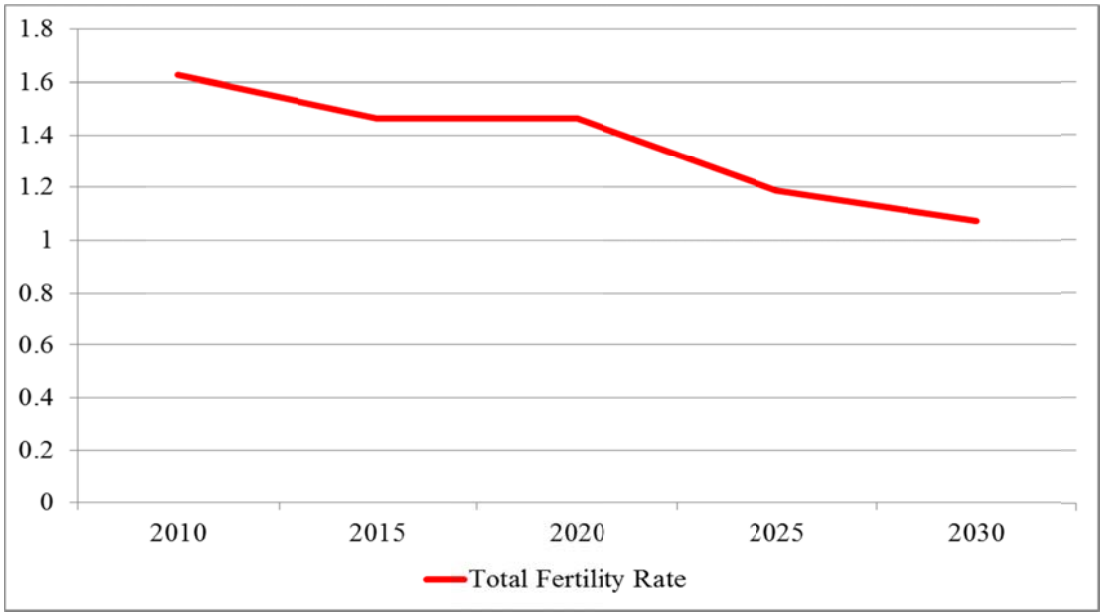

Figure 5 Total Fertility Rate (TFR) based on Prospective Trends for Puerto Rico, 2010-2030

The TFR expected to continue declining in the coming years reducing to the lowest low by 2030. This reduction in fertility, despite being conservative, is likely to impact the future age structure of the population and the overall priorities of the government of Puerto Rico. For purposes of our projections we will use the fertility levels for 2010, as a continued reduction

would not impact significantly the number of births for the coming years. The implication of low fertility will be discussed later in this paper.

Mortality: A stable element of Puerto Rican demography

We calculated baseline mortality using the population structure from the 2010 Census. Data on deaths came from the Puerto Rico Death Files from the National Center for Health Statistics (NCHS). We calculated Mortality Rates for each age group and sex, which were incorporated in the life tables and used to derive the Survival Rates for each sex/age-group. To incorporate mortality in the population projections we calculated Sex Specific Life Tables and calculated the Survival Rates for each group.

Consistent with usual mortality indicators in developed countries, male mortality is higher than female mortality. This difference is present in the young adult ages and more marked in the over 40 year old age-groups. This marked differentials in mortality rates, also translate in differentials in Life Expectancies. According to our life tables males have a life expectancy at birth of 75.38 and females had 83.24 years, these results are very similar to the calculations published by the Puerto Rico Department of Health. The Puerto Rico Department of Health calculated the life expectancies in 2013 as 74.85 for males and 82.56 for females, a difference of half a year and three quarters of a year (Departamento de Salud, 2013).

We did not incorporate a prospective trend change in this scenario because when we explored the mortality estimates they were found to be very robust and stable with minimal or no change in mortality rates for most age-groups. This means that for our population projections, we will incorporate mortality, through the 2010 Survival Rates obtained from the Life Tables.

Migration: Fluctuating and Different Magnitude Scenarios

Migration was the more complicated component to calculate. We calculated Net Migration Rates through the Vital Statistics Method or the Residual Method. This method starts with a base population (2000) and then subtracts the deaths from each age group (n), proceeds to move forward the age structure (n+1) and add the births as the new zero age group. This is done for all intercensal years and the resulting population is then compared with the decennial count (2010) to calculate the population residual. This component was incorporated to the population projections through a variety of scenarios. Figure 6 presents the population residual or net migration rates calculated using the aforementioned method.

Migration was incorporated to the population projections through three possible scenarios. The first scenario was full migration, which assumes migration will continue the same level as in the 2000-2010 decade. The second migration is the half migration scenario, which

assumes migration will reduce to half of what it was in the previous decade. A final scenario, calculated for purposes of illustrating the effect of migration and deemed to be used as a reference, is a zero migration scenario, where net migration is assumed to be zero.

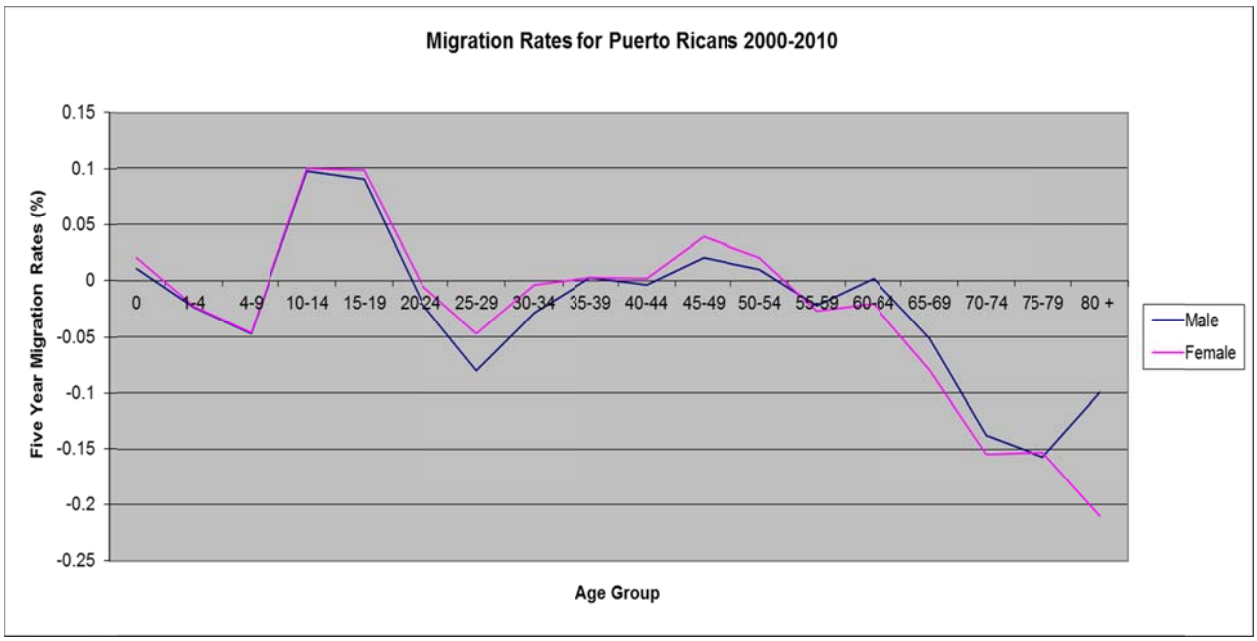

Figure 6 Migration Rates for Puerto Rico, 2000-2010

As it can be appreciated in Figure 6, migration is seen in very similar ways for Males and Females. The current economic crisis (Figueroa-Rodriguez and colleagues, 2012) has acted as a push factor for work-age Puerto Ricans evidenced by the outmigration seen in the 20-30 age groups. An unusual trend is seen in the adolescent populations who have high levels of net migration (positive balance). A previously unaddressed fact is the outmigration (negative net migration) of aged population; this outmigration influences the pace of aging in Puerto Rico by slowing or reducing its magnitude. We have censored outmigration of aged population to 0.10 or 10%, and have incorporated a reduction in the immigration of adolescent population for years after 2010. Apart from those two measures, we allowed variation in Net Migration Rates by altering the magnitude of the flow of population to the three aforementioned scenarios as well as reducing the positive net migration after 2010.

RESULTS

In Table 1 we present the total for the population projections from 2005 until 2030, for the three different migration scenarios. As it can be appreciated by 2030 the population of Puerto Rico is expected to decline below the levels in which they were in 2000 (3.8 millions). Only the Zero Migration scenario puts the population of the island above the 2000 level, but

this scenario has high levels of error (Table 3) and is not likely to happen as migration has been a constant in Puerto Rican population dynamics since the 1900s. The results of the Zero Migration will not be discussed in detail in this paper. The other two scenarios mark 2015 as the year until which the population of Puerto Rico had potential to grow. After it, a marked decline is likely continue and by 2030 the population of the island could reach 3.2 million if the trends continue as projected.

Table 1 Population Projections by Scenario for Puerto Rico, 2005-2030

Scenario	2005	2010	2015	2020	2025	2030
Full Migration	3,729,700	3,711,330	3,638,330	3,528,582	3,385,355	3,221,535
Half Migration	3,786,253	3,819,867	3,795,473	3,735,976	3,625,286	3,491,678
Zero Migration	3,826,070	3,900,201	3,925,402	3,909,868	3,850,520	3,764,940

In Table 2, we present the principal indicators of the population projections for the three migration scenarios considered. These are Median Age, % of the Population under 20 and 65 and older, the dependency ratios and the disaggregated dependency ratios for Puerto Rico. Population Pyramids are included in Appendix 1. The 2010, as well as the projected population illustrated in the pyramids point to the population of Puerto Rico entering and having a structure of contraction, which is consistent with the finding of decreasing population, migration seems to play an important role in the pace of the transition to an “inverted pyramid” structure for Puerto Rico. Despite the influence of migration, all scenarios point to an inverted pyramid structure by 2030.

Table 2 Population Indicators for Projected Scenarios, Puerto Rico 2000-2030

Indicator	**Full Migration Scenario**					
	2005	**2010**	**2015**	**2020**	**2025**	**2030**
Median Age (years)	38.51	39.99	40.14	42.18	44.61	46.71
% Population < 20	24.88	22.91	21.38	19.87	18.03	15.81
% Population 65 +	16.46	17.86	19.54	21.28	22.74	24.17
Dependency Ratio	51.85	52.96	54.38	55.17	54.04	54.04
Child Dependency Ratio	26.86	25.65	24.21	22.15	19.02	16.80
Aged Dependency Ratio	24.99	27.31	30.17	33.02	35.03	37.23
Indicator	**Half Migration Scenario**					
	2005	**2010**	**2015**	**2020**	**2025**	**2030**
Median Age (years)	38.67	40.28	40.21	43.53	45.42	47.58
% Population < 20	24.75	22.74	21.05	19.57	17.66	15.40
% Population 65 +	17.17	19.19	21.28	23.29	25.01	26.64
Dependency Ratio	53.45	55.77	57.89	59.71	59.10	59.47
Child Dependency Ratio	27.10	25.88	24.29	22.51	19.31	16.98
Aged Dependency Ratio	26.35	29.90	33.61	37.19	39.80	42.49
Indicator	**Zero Migration Scenario**					
	2005	**2010**	**2015**	**2020**	**2025**	**2030**
Median Age (years)	38.70	40.34	40.21	43.51	45.30	47.25
% Population < 20	24.70	22.71	21.12	19.61	18.28	16.66
% Population 65 +	17.58	20.01	22.32	23.28	25.98	27.35
Dependency Ratio	54.50	57.66	60.69	59.77	64.49	64.31
Child Dependency Ratio	27.33	26.11	24.83	22.57	21.01	19.36
Aged Dependency Ratio	27.17	31.55	35.86	37.19	42.47	44.95

Source: Population Projections completed using Cohort-Component Method

According to our projections, the median age will increase in Puerto Rico with migration being influential in this increase. In the case of the Full Migration Scenario, the median age would go up to 46.71 years, 47.58 years for the Half Migration and 47.25 for the Zero Migration by 2030. This indicates that the population of Puerto Rico will be aging; the pace of this increase will be 2 years per decade. In relation to proportions in specific age groups, the diverging trends in the younger than 20 years and the over 65 years old population is notable. Regardless of the migration scenario, Puerto Rico will experience a dramatic reduction in the population younger than 20 years which is highly influenced by the decrease of fertility and the migration of individuals in reproductive ages. Additionally, the migration trends for the 2000-2010 and the current moment indicate that migration is no longer of an individual but of whole families. The

increased number of persons in working and reproductive ages is also accompanied by the migration of their offspring to the mainland United States.

For the other group of interest (population 65 years and older) the projections indicate this sector of the population will be around 24.17% and 27.35% by 2030, which supports our previous result of the marked increase in Median Age. The migration scenarios play an important role here, in the case where zero migration is considered, the proportion of individuals over 64, is closer to 30% of the population, whereas in the other two scenarios this sector of the population remains lower. A previously non-noted trend in the migration dynamics of the island is the migration of persons who are over 65 years old. According to our calculations, the migration of individuals in these age groups fluctuate between -16% and 0% for specific age cohorts, with an increased level of outmigration found for individuals over 70 years old.

The final indicator presented in Table 2 deals with the Dependency Ratio. The dependency ratio gives us a notion of how many persons are not likely to be active in the economic/labor market versus the number of individuals who are in highly productive ages in terms of labor force participation and economic activity. The disaggregated ratios also provide an idea of how each component of the ratio is behaving as time passes. This ratio increases to 54.04 persons by 100 persons in the working age group in the Full Migration scenario. In the case of the Half Migration scenario, the dependency rate goes from 53.45 persons by 100 persons in the working age groups to 59.47. The increment in the dependency rate is fueled by the aging of the population of Puerto Rico, which has been discussed previously by ways of the proportion of individuals in the under 20 and over 64 age groups. The results for the Zero Migration are also presented in Table 2. When considering the independent effect of each component of the Dependency Ratio, we found that the changed in the overall Dependency Ratio is heavily influenced by the increase in Aged Dependency Ratio and the decrease in the Child Dependency Ratio. This increase of the Aged Dependency Ratio is greater than the decrease of the Child Dependency Ratio. The implications of these results for the public and private sectors, as well as for public policy purposes will be developed in the Discussions section of this paper.

Measurement of Errors for Population Projections

Our projection strategy was to use the 2000 population structure as a base year and to project the 2005 and 2010 using our assumed fertility, mortality and migration scenarios. The total count for the projections was compared with the 2010 Census Count for purposes of understanding the margin of error of our projections.

We use the Mean Percent Error (MPE) as a measure of error. The MPE is a measure of the percentage of population under or overestimated in comparison to a known value in this case the decennial census count. The results for the evaluation are presented in Table 3.

Table 3 Mean Percent Error (MPE) for Population Projections

Scenario	2010 Projection	2010 Census	Mean Percent Error
Full Migration	3,718,078	3,725,789	-0.21
Half Migration	3,819,867	3,725,789	2.53
Zero Migration	3,900,201	3,725,789	4.68

As it can be appreciated the Full Migration Scenario closely projects the total population with an underestimation of less than one percent (-0.21%). In the case of the Half Migration and the Zero Migration, these scenarios overestimate the total population of Puerto Rico by 2.5% and the 4.63%; this indicates that the zero migration scenario should not be considered when using projections for public policy and planning decisions. Despite these marked levels of error, the population structure indicators are fairly similar for the three scenarios. In future cases the half migration and full migration should suffice in terms of projection scenarios being considered.

DISCUSSION

The decline and systemic aging of the population of Puerto Rico has important implications for in the economic stability of the island. The common elements of major economic theories have the population as a factor that can influence the supply and demand of services and products (Parkin, 2015). Furthermore, taxation policies consider population size and structure important for purposes of taxes. An increase in the dependency rates has been correlated with a decrease in tax rates and tax revenues (Razin and colleagues, 2001). From this perspective, we understand that the demographic trends observed in our projections will have numerous implications if they are not addressed in a timely manner.

The first implication is the added pressure to public funded health, long term care, and insurance and welfare support programs for older population. The government of Puerto Rico funds numerous programs to help older population cope with their medical and social needs. One of these programs is the healthcare reform, older population use the Puerto Rico Health Insurance (“la reforma”) as means to obtain medicines, primary and specialist care. Even in today’s paradigm the PR Healthcare Reform has been found to have low levels of stability, and the government has not been able to deal with the increasing amount of expenses that come from the need for more services of the aged sector of the population (Santos-Lozada, 2012).

The likelihood of the aged population continuing to rely in this insurance for their health needs is likely to continue or increase in the coming years.

The shift to chronic illnesses such as heart conditions, strokes, chronic obstructive pulmonary disease, Alzheimer, and diabetes related conditions are likely to increase with the aging of the population. These diseases do not have a cure, meaning persons and physicians will have to shift their priorities to coping and living with the diseases instead of eliminating the illness. Additionally, the Puerto Rico Healthcare System will have to start caring for persons with multiple diseases, which will pose as a challenge for purposes of financing public health insurance like the one that is in place. A more overarching discussion of these trends and their implications are found in Wiener and Tilly (2002) where they approach the situation of population aging in the case of the United States.

The emergence of an aged sector of the population will undoubtedly be accompanied by the emergence of long-term care centers, for persons who are coping with terminal diseases or whose offspring and family are not able to take care of. A recent presentation by Santos and Marazzi (2014) pointed to the population living in long-term care centers increasing in Puerto Rico during this decade.

In terms of income, the aged population of Puerto Rico has been found to be highly dependent on income supplements and pension systems. A study by the Puerto Rico Catholic University has found that 39% of the aged population lives below the poverty level in Puerto Rico. The heavy dependence on public pensions and income supplements highlights the vulnerability of this population to the economic instability of the government.

The Puerto Rico government has found it difficult to meet their financial obligations during the last 2 years. A battery of financial reforms to Public Employee (Puerto Rico Act 3, 2013), Teachers (Puerto Rico Act 160, 2013) and Judge (Puerto Rico Act 163, 2013) Retirement Systems have either not solved the financial crises of the retirement systems or have been declared unconstitutional by the Puerto Rico Supreme Court. This last fact adds more pressure to the government as a big sector of the population (“baby boomers”) will be retired in the coming years thus aggravating the delicate situation of these pension systems. The increase in the dependency rate will further aggravate the economic conditions and stability of these retirement systems as well as of welfare income supplements for the elderly and the poor.

The population 65 years and older will require modifications in the services requested and available for this sector of the population. Health services are a priority in this list. Some questions that need to be addressed by the government and the policymakers include: (1) Is the public health insurance able or prepared to finance more beneficiaries who will need more services?, (2) Do health facilities and medical offices have the appropriate infrastructure and

specialized staff to provide quality services for this increasing sector of the population?, (3) Does work-age population will be able to undertake or sustain the older sector of the population? Regardless of other questions we can postulate the implications of an aging population in Puerto Rico requires a strategic plan which incorporates the demographic change and how we will address these challenges in the short and long terms.

A drastic reduction in school-aged children will undoubtedly bring challenges to the current structure of the government and the Puerto Rico Education System. At the moment in which this paper is being written the government deals with a drastic reduction in school-aged children and with a big education system. Since 2011, the government has merged education regions, consolidated schools and even closed teaching institutions. In 2014, 4,000 teachers were identified as at risk of not having students to teach, this represents a 10% of the faculty of the public education system of the island. Despite the drastic reduction in school-aged children education faculties continue to recruit students in higher numbers, a growing proportion of these students end up working as teachers in states like Texas, Oklahoma, Florida, New York or Pennsylvania.

Currently the Puerto Rico Department of Education (PRDE) has a budget of 3.6 billion dollars this is more than the total budget of some Latin American countries like Dominican Republic. The significant reduction in the number of school-aged children will undoubtedly bring forth challenges for the future of the PRDE. Either the government will have to reduce the number of teachers and schools or they could refocus their resources into education with a lower teacher-to-student ratio which has been consistently associated with positive outcomes in student learning. The current trend indicates the Puerto Rico Department of Education has taken the first option.

Finally, the history of Puerto Rico has been marked by constant migration. During the last decade, the out-migration increased, the migration rates shown before in the paper suggest a negative balance for the young adult and adult population (20-30 years). According to the American Community Survey (ACS) the median age for emigrants oscillates between 27 to 30 years (Rodriguez Ayuso and colleagues, 2011). The lack of opportunities in the labor force for the young adult population is a principal force behind this migration trend. Even in the situation, we should measure quality of job opportunities and improve them in order to slow down the pressure thus reducing the outmigration. An implication of the young adult outmigration is this group also belongs to the reproductive age influencing the decrease in the fertility rates and as a consequence we project a significant reduction under 20 years from 24% to a projected 15% by 2030.

For purposes of public policies the government of Puerto Rico has relied in the approval of new taxes to meet their financial obligations. The taxes have a regressive effect in the

economy and act as push factors in terms of migration of the population. A clear example was the taxation to petroleum or “la crudita”, after a tax was imposed in 2013, it was revised and increased in 2014 because the projected revenues were not met and were already assigned to the Puerto Rico Department of Transportation and Public Works. As of today the reduction of population is highly influential in the decline and shortage of tax revenues.

We understand that the issues of population decline and population aging have to be addressed immediately by the government of Puerto Rico. The measures should be geared towards coping with an increasing sector of the population that will need more support in terms of social welfare, income support, protections and to protect the stability of the pensions of these populations. Additionally, the failure to meet tax revenue projections should also be understood as a population issue instead of a tax evasion or a contraction of the economy. A decreasing taxable base (populations being taxed) will translate in lower revenues even if taxes are raised or more taxes are approved. The population element/dimension of public, welfare and economic policies should not be ignored in future efforts to deal with the economic crisis of Puerto Rico.

LIMITATIONS

We identified three key limitations for our study. The first is that Puerto Rico stopped collecting race/ethnic backgrounds after the 1990 Census. The decision based in the notion that “we are all Puerto Ricans” has left a gap in how we can address and understand transformations based in the ethnic background of the population of the island. A step forward could be to start collecting this information not only in special forms in the Decennial Census but also in birth and death certificates, as well as in future population based surveys. Policy makers should rescue the ethnic background categories that reflected the historical and demographic roots of some sector of the population.

The second limitation we found was with the calculation of net migration rates, although we performed various sensitivity analyses we relied on actual trends and non-published information to allow some variation in the migration rates for the post-2010 years. This allowed us to be conservative with regards to the magnitude of net migration and its impact in our population projections.

A third limitation emerges from the absence of demographic literature that deals with the Puerto Rico population dynamics apart from work from the late 90s, and early 2000s most of the literature was published between 1950 and 1990, which does not allow us to compare our result to other works. Despite these limitations, we understand that our paper presents the first analysis of its kind in the post-population decrease era.

FUTURE DIRECTIONS

An idea beyond the scope of our analysis is to develop a paper that considers an acceleration of the migration and a faster decline in fertility levels could add up to the literature and to the discussion of Puerto Rico's population prospects. A possible development of this method is to calculate a scenario in which migration accelerates (1.5 migration scenario), and immigration reduces gradually. Despite being an interesting postulate this seems like a work we need to ponder based on the current trends of the population of Puerto Rico. These trends will be consulted using the Puerto Rico Community Survey for another study.

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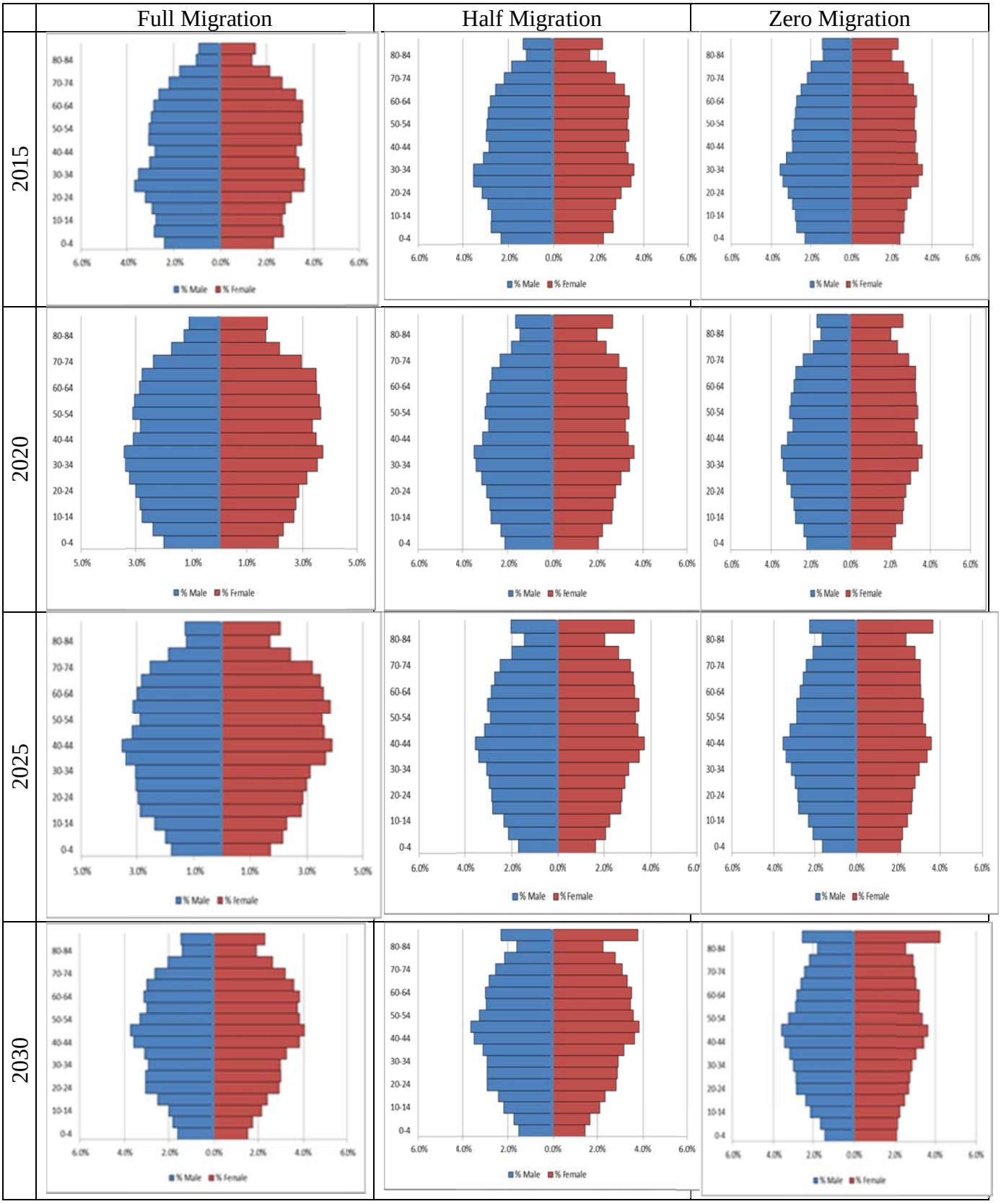
Appendix

Appendix 1 Population Pyramids for Puerto Rico by Migration Scenario, 2015-2030



Endnotes

[i] The opinions or assertions contained herein are the private views of the authors and are not to be constructed as official or as reflecting the views of the institutions they are affiliated with.

[ii] This research was supported in part by an appointment to the Study Research Participation Program at the U.S. Army Institute of Surgical Research administered by the Oak Ridge Institute for Science and Education through an interagency agreement between the U.S. Department of Energy and USAMRMC.

[iii] Calculations were performed using 2000 and 2010 US Census population structures. Births and deaths for the period were adjusted to avoid double accounting of events and to reflect population for April 2010.